Washington State Department of Health (DOH)
Nitrates in Drinking Water
Position Paper

Purpose

Nitrate contamination of drinking water supplies is an issue of concern for regional, state, national and international public and environmental health practitioners. Ingestion of nitrate can cause anemia and, if not treated, death to young infants. The information in this paper is intended to increase local health officials' understanding of nitrate contamination in water and provide helpful recommendations in addressing these problems.

Background: What is the Contaminant, What is the Concern

Nitrate is considered an "acute contaminant" because short-term exposures to levels above the Maximum Contaminant Level (MCL)[1] can cause methemoglobinemia, a blood disorder, in sensitive individuals (especially young infants). Elevated levels of nitrate may also indicate that the water source is susceptible to other contaminants, such as microbial pathogens and pesticides.

The MCL for nitrate is 10 milligrams per liter (10 mg/l). Unlike most drinking water MCLs, the nitrate MCL is based upon an observed human effect in highly sensitive persons. There is no safety factor incorporated into the standard. In fact, cases of methemoglobinemia are known to have occurred in infants exposed to nitrate concentrations only slightly above 10 mg/l.

No information is currently available linking adverse health impacts for Washington residents to nitrate exposure through drinking water. However, portions of Adams, Benton, Clark, Franklin, Grant, Thurston, Walla Walla, and Whatcom Counties have nitrate concentrations in ground water that exceed 10 mg/l. Of particular concern are persons using private or domestic (nonpublic) wells that receive little or no water quality monitoring. Without monitoring, users may not realize they are being exposed to elevated nitrate levels. In addition, nitrate concentrations often fluctuate, so a single sample may not represent the average or peak concentration within the water supply.

Source of the Contaminant/Agent: Common Routes of Exposure

Sources of excess nitrate in drinking water include fertilizers, animal manure piles, and septic systems. Shallow wells, poorly sealed or constructed wells, and wells that withdraw from unconfined water table aquifers are at highest risk.

Infants are most commonly exposed to high nitrate levels when contaminated drinking water is used to make formula and beverages.

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[1] The maximum permissible level of a contaminant in water delivered to any public water system user. Nitrate is generally measured as NO_3-N (nitrate-nitrogen). When measured as nitrate-nitrogen, the MCL is 10 milligrams per liter (mg/l). It can also be measured as nitrate only, in which case the MCL is 45 mg/l NO_3.

Affected Populations and Clinical Manifestations

At particular risk are infants less than one year old, pregnant women, and persons of all ages with reduced gastric acidity or a hereditary lack of methemoglobin reductase. In some situations, ingestion of high levels of nitrate leads to methemoglobinemia, a condition that renders the hemoglobin in an individual's red blood cells less capable of transporting oxygen from the lungs to the rest of the body. This can result in an anemic condition. A dusky or blue hue may affect the skin tone of persons who suffer methemoglobinemia. Untreated, the condition can be fatal. Elevated levels of nitrate also can cause diarrhea and other gastrointestinal symptoms.

Based upon national data, even short-term consumption of water with nitrate levels above the MCL can cause methemoglobinemia in infants less than one year of age. At greatest risk are infants younger than three months. As the infant matures, its blood changes over from fetal hemoglobin to adult hemoglobin. As the infant reaches six months of age, most of the hemoglobin is adult hemoglobin. Susceptibility decreases then and the symptoms disappear. Any damage caused by anemia in the early months of life may not be detectable for several years.

Labored breathing, low blood pressure, below average weight gain, failure to meet developmental milestones, and respiratory exhaustion are additional findings in young infants[2]. Methemoglobinemia is difficult to diagnose and is easily mistaken for other "normal" early infant illnesses involving fatigue, diarrhea, lassitude, or failure to thrive. Often the illness may be misdiagnosed unless death occurs and the condition is detected during autopsy, if a blood sample is taken, or the dusky or bluish skin color is observed by a parent or health care provider aware of the potential for methemoglobinemia caused by drinking water.

Public Health Implications

Among infants less than one year old, pregnant women, and persons of all ages with reduced gastric acidity or a hereditary lack of methemoglobin reductase, those most at risk for exposure are those who depend upon private domestic wells for their drinking water. Most private domestic wells are shallow, often located near potential sources of nitrate contamination (such as septic tanks or agricultural areas), and rarely have their water quality assessed on a periodic basis.

Determination of how common methemoglobinemia caused by exposure to nitrate-contaminated drinking water has been in Washington is difficult because methemoglobinemia is not a reportable illness. Available data are based upon mother or health care provider recall. Until caregivers are made more aware of the potential for methemoglobinemia, the number of cases reported will not be a reliable measure of the problem. Instead, the seriousness of the potential health impacts to infants and other sensitive populations is the criteria defining the public health significance.

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[2] Please refer to *ATSDR's Case Studies in Environmental Medicine: Nitrate/Nitrite Toxicity* for more detailed information on diagnosis and treatment of methemoglobinemia. See reference section at the end of this paper for information on how to obtain a copy.

Legal Standards and/or Requirements

The MCL of 10 mg/l for nitrate-nitrogen in drinking water was established by the World Health Organization and the US Environmental Protection Agency. This level was adopted as a standard by the Washington State Board of Health under Chapters 246-290 and 246-291 WAC.

Public water systems are required to monitor nitrate concentrations on a periodic basis (every one to three years). If nitrate concentrations above one-half of the MCL are detected, the water system is required to monitor the source on a quarterly basis. If a concentration above the MCL occurs, the water system must notify all customers so sensitive individuals can be protected. Public water systems also are required to evaluate the development of alternate drinking water sources and treatment/blending options when technologically and economically feasible to reduce the nitrate concentration.

Legal water quality monitoring requirements for owners of private domestic drinking water wells apply only at the initial approval stage. Depending upon when and where the well was drilled, requirements for monitoring for nitrates at the time of drilling or subsequently may not exist.

Recommended Prevention and Response Actions

Most preventive measures and response actions to address nitrate contamination in Washington fall into one of several major categories: new drinking water source approvals; public health surveillance and assessments; educational outreach, including targeted outreach for private well owners; and continued environmental assessments/data collection.

New Source Approvals

One of the most effective preventive measures is to reduce or eliminate the use of nitrate-contaminated water by new drinking water systems. DOH and local health jurisdictions can accomplish this by coordinating with building officials during water supply adequacy and potability determinations for building permit applications under the state's Growth Management Act.

Future water quality monitoring for potability and adequacy of drinking water in Washington should include nitrate as an analyzed parameter.

New Public Water Systems

When nitrate is detected at concentrations between 5 mg/l and 10 mg/l, public water systems are required to monitor for nitrate on a quarterly basis to better characterize changes over time; evaluate potential sources of nitrate, other contaminants, and microbes; and identify available resources for installing, operating, and maintaining a water treatment process or other mitigation measures.

If the concentration of nitrate equals or exceeds the MCL (10 mg/l), public water systems should be required to install and operate a water treatment system, or take other mitigation measures that will reduce nitrate (plus any other contaminants) concentrations below the MCL.

Public water systems should also be required to show the capability to maintain the water treatment process (or other mitigation measures) over an extended period of time prior to receiving approval or a finding of adequacy.

New Individual Water Systems

Health officials should consider requiring private water systems that exceed 5 mg/l of nitrate be connected to existing or future public water systems. State guidelines already recommend water treatment systems be installed if nitrate concentrations exceed the MCL of 10 mg/l.[3]

Owners or developers of private domestic water systems with nitrate levels at or above 10 mg/l should be required to treat water or provide alternate drinking water supplies if they serve vulnerable persons (e.g., infants less than one year of age, pregnant women, and persons of all ages with reduced gastric acidity or a hereditary lack of methemoglobin reductase). These owners or developers also should be required to inform future owners or consumers of the potential hazards associated with elevated nitrate concentrations (disclosure on the property title plus other mechanisms).

Personal Health Surveillance and Assessments

Immediate, ongoing efforts should be taken to identify and educate vulnerable persons and their health care providers about the potential dangers of nitrate ingestion so they will evaluate the quality of their drinking water supplies.

In conjunction with local public health agencies, the DOH Office of Environmental Health Assessment Services will evaluate establishing an epidemiological surveillance program to detect any new cases of methemoglobinemia for investigation and intervention.

Educational Outreach

Health care professionals and the public should be made aware of the potential hazards and clinical manifestations associated with elevated nitrate levels in drinking water, especially methemoglobinemia. Development and distribution of appropriate educational materials is a joint responsibility of the state and local health jurisdictions. DOH will take the lead in developing educational materials and will assist local health jurisdictions in their distribution.

In areas where evidence suggests there may be nitrate contamination of ground water used for drinking, educational materials should be developed and distributed to private well owners. These materials should explain why it is important to monitor drinking water quality, ways to minimize current and future risks of contamination, and how people can get their well water tested. It is important that these educational materials be used in conjunction with efforts to implement long term solutions to reduce nitrates.

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[3] *Guidelines for Determining Water Availability for New Buildings*, Washington State Departments of Ecology and Health, Ecology Publication 93-27, 1993.

Continued Environmental Assessment

Public and environmental health agencies should continue to assess water supplies to determine the extent and degree of nitrate contamination, incidence of health effects, and the characteristics of the affected persons. When wells are determined to be contaminated with nitrate, a site-specific evaluation should be made to identify the source of the nitrates and corrective measures to lower nitrate concentrations. Efforts to better coordinate water quality data collection and management are needed to summarize and analyze existing information, and identify data gaps and problem areas.

The state Interagency Ground Water Committee is the appropriate lead entity at the state level to lead this data management project.

References

An overview of diagnosing nitrate toxicity is presented in the *ATSDR's Case Studies in Environmental Medicine: Nitrate/Nitrite Toxicity*. Copies of this document can be obtained by contacting ATSDR at:

Continuing Education Coordinator
Agency for Toxic Substances and Disease Registry
Division of Health Education, E33
1600 Clifton Road NE
Atlanta GA 30333

Department of Health Points of Contact:

Division of Drinking Water	- David Jennings	(360) 236-3149
Office of Epidemiology	- Paul Stehr-Green	(360) 236-4240
Interagency Ground Water Committee (Department of Ecology)	- Diane Dent-White	(360) 407-6616
WEBSITE:	- http://www.doh.wa.gov/ehp/dw	